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# FINAL REPORT:
# HERBICIDE, NUTRIENT AND WATER DRAINAGE FROM AN IRRIGATED FIELD

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# EXECUTIVE SUMMARY

## HERBICIDE, NUTRIENT AND WATER DRAINAGE FROM AN IRRIGATED FIELD

A three year study (1986,1987 and 1988) was conducted to determine the herbicide, nutrient and water losses from a typical farm field irrigated with the corrugation method. Most of the losses of herbicides (MCPA, DICAMBA, DICLOFOP and 2,4-D) occurred during the first irrigation of the season with the first flush of drainage water. The magnitude of the concentrations are considered to be below the LC 50 limits of 10 ug/l for aquatic invertebrates (USEPA 1983). The losses in terms of the amount applied were all less than 1% which is comparable to amounts observed in spring runoff from dryland agricultural fields.

The amount of nutrients lossed were also considered to be low and comparable to observed in 'catastrophic' rainfall runoff event from dryland agricultural fields observed in studies in the United States (Wauchope 1978).

The average amount of drainage water was also considered to be comparable to observations made in Alberta.

In summary, the main negative impact of surface irrigation was the flush of applied herbicides and nutrients that occurred with the first irrigation. If drain water is to be reused, it may be advantageous to avoid using drainage water that occurred with the first irrigation.

## SUMMARY

With the growing interest in expanding irrigation in Canada, the use of irrigation return flows is being explored. These can improve overall irrigation efficiency and reduce the unit costs of irrigation development. However, it is necessary to determine if this practice is environmentally sound. In addition, with increased costs in irrigation farming, the efficiency of the application of irrigation water, nutrients and herbicides must be examined. If efficiencies are not high, alternative management techniques such as fertigation may be considered. Finally, the impact of irrigation return flows on receiving waters should be evaluated. To this end, a study supported by the Saskatchewan Agriculture Development Fund was initiated in 1986 to examine the herbicide, nutrient and drainage water from a field irrigated by the gravity corrugation method. The objectives of the study were to determine:

1. The amount of surface drainage water following each rainfall and irrigation event;
2. The quality of surface drainage water with respect to nutrients and herbicides;
3. Irrigation efficiency with respect to application of irrigation water, nutrients and herbicides;
4. The impact of irrigation drainage and downstream flows on water quality.
5. The opportunity for the reuse of irrigation drainage water downstream.
6. The effect of application techniques (e.g. pre- or or post- ) and/or crop situation by selecting different monitoring sites each year.

Irrigating a soft white spring wheat crop in the South Saskatchewan Irrigation District in the 1987 ,1988 and 1989 crop season using the corrugation method resulted in the following:

1. In 1986 2.4 cm(14.3%) of the applied irrigation water was returned as surface drainage water while 1987 had 2.71 cm (10.5%) return as surface drainage water. By comparison, in 1988 6.2 cm(23.1%) of the applied irrigation water was returned as surface drainage water. On the average, the amount of surface drainage from the corrugation irrigation is comparable to the literature from Alberta and could be used for estimating irrigation return flow directly off farm fields.

2. In 1986 0.12 kg/ha(0.1 %) of the applied nitrogen and 0.07 kg/ha (0.12%) of the applied phosphorous was lost to surface drainage. By comparison 1987 had 0.15 kg/ha(0.1 %) of the applied nitrogen and 0.06 kg/ha(0.22 %) of the applied phosphorous lost to surface drainage. In 1988, 0.43 kg/ha(0.48 %) of the applied nitrogen was lost while no phosphorous was applied. The loss of applied fertilizers is considered to be low when compared to the loss of nutrients from an unfertilized fallow field under dryland conditions (Nicholaichuk and Read, 1978).

3. Maximum concentrations of nutrients and herbicides were observed as follows:

| 1986 | 1987 | 1988 |
|---|---|---|
| - 0.40 mg/L total p | 0.75 mg/L total P | 1.12 mg/L total P |
| - 0.26 mg/L ortho-P | 0.36 mg/L ortho-P | 0.45 mg/L ortho-P |
| - 0.74 mg/L diss. N | 1.95 mg/L diss. N | 3.34 mg/L diss. N |
| - 0.54 mg/L total N | 0.24 mg/L total N | 0.66 mg/L total N |

- In 1986, 0.13 g/ha or 0.12% of the applied Dicamba and 0.47 g/ha or 0.11% of the applied MCPA was observed in the surface drain water from both irrigations. In comparison, 1987 had 0.18 g/ha or 0.17% of the applied Dicamba, 0.56 g/ha or 0.13% of the applied MCPA and 1.37 g/ha or 0.18% of the applied Diclofop was observed in the surface drain water from all irrigations. In 1988 0.32 g/ha or 0.06% 2,4-D, 5.85 g/ha or 0.73% Diclofop and 2.07g/ha or 0.74% of the applied Bromoxynil was observed in the surface drain water from all irrigations. Although comparative data for the loss of Dicamba, MCPA and Diclofop are not available for dryland agricultural conditions in Saskatchewan, the loss of 2,4-D was found to be comparable for surface irrigated conditions compared to spring runoff fields where fall 2,4-D was applied (Nicholaichuk and Grover, 1983).

Based on the surface drainage discharge and hourly observations of concentrations of MCPA and Dicamba, most of the loss occurred during the first irrigation. However, the amount of loss is a very small percentage of the amount applied. The 0.17% loss of Dicamba was far less than 3.3% loss observed in a simulated 'catastrophic' rainfall event observed by Wauchope(1978).

Data suggests that herbicide losses occur primarily during the first irrigation. As a result, if drain water is to be reused for subsequent irrigations, it may be necessary to avoid using the surface drain water that occurs after the first irrigation for very sensitive crops.

Loss of both nutrients and herbicides is a function of agronomic practices. Suitable land use practices such as minimum tillage and crop rotations that minimize erosion and runoff losses will result in minimal environmental contamination through the use of chemical fertilizers and herbicides.

# FINAL REPORT

# HERBICIDE, NUTRIENT and WATER DRAINAGE

# from an

# IRRIGATED FIELD

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## ABSTRACT

Based on a three year study (1986,1987 and 1988), irrigating a soft white spring wheat (Triticum aestivum) by the corrugation method, has resulted in 14.3%, 10.6% and 23.1% respectively, of the applied irrigation water being returned as surface drainage water.

In 1986, 1987, and 1988, 0.1% (0.12 kg/ha), 0.1% (0.15 kg/ha) and 0.5% (0.43 kg/ha) repectively, of the applied nitrogen was lost to surface drainage water. Similarly for phosphorus, 0.1% (0.07 kg/ha) was found in 1986, 0.2 % (0.06 kg/ha) was found in 1987. No phosphorus was applied in 1988.

With respect to the loss of applied herbicides, in 1986, the maximum concentrations observed was 4.3 ppb Dicamba and 10.7 ppb MCPA, compared to 4.7 ppb Dicamba, 12.9 ppb MCPA and 17.4 ppb Diclofop in 1987. In 1988, 3.5 ppb of 2,4-D, 63.8 ppb of Diclofop and 20.4 ppb of Bromoxynil was observed. In 1986, these losses to drain water represent 0.1% (0.13 g/ha) Dicamba and 0.1% (0.47 g/ha) of MCPA of the amount applied. Compared to 1987, 0.2% (0.18 g/ha) of Dicamba, 0.1% (0.56 g/ha) of MCPA and 0.2% (1.37 g/ha) of Diclofop was lost. In 1988, 0.1% (0.32 g/ha) of 2,4-D, 0.7% (5.85 g/ha) of Diclofop and 0.7% (2.07 g/ha) of Bromoxynil was observed.

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## INTRODUCTION

The full impact of irrigation development on the Canadian Prairies has not been fully assessed. The efficiency of irrigation conveyance systems has been studied in Southern Alberta (Manz 1984). Irrigation efficiencies of irrigation districts in southern Alberta have been summarized (Heywood 1978). However, none of these studies addresses the question of both the quantity and quality of drainage water that can be expected from surface irrigation.

In the United States, the International Joint Commission review of the Garrison Diversion Project for irrigation in North Dakota (International Joint Commision Garrison Diversion Study Board Report 1976) recommended a 5000 acre field study to assess the impact of irrigation. Although the study was initated, (U.S. Dept. of the Interior, 1980), progress was halted as a result of a U.S. Presidential Commission Review.

With the growing interest in expanding irrigation in Canada, the use of irrigation return flows is being explored. These can improve overall irrigation efficiency and reduce the unit costs of irrigation development. However, it is necessary to determine if this practice is environmentally sound. In addition, with increased costs in irrigation farming, the efficiency of the application of irrigation water, nutrients and herbicides must be examined. If efficiencies are not high, alternative management techniques such as fertigation may be considered. Finally, the impact of irrigation return flows on receiving waters should be evaluated. To this end, a study supported by the Saskatchewan Agriculture Development Fund was initiated in 1986 to examine the herbicide, nutrient and drainage water from a field irrigated by the gravity corrugation method. The objectives of the study were to determine:

1. The amount of surface drainage water following each rainfall and irrigation event;
2. The quality of surface drainage water with respect to nutrients and herbicides;
3. Irrigation efficiency with respect to application of irrigation water, nutrients and herbicides;
4. The impact of irrigation drainage and downstream flows on water quality.
5. The opportunity for the reuse of irrigation drainage water downstream.
6. The effect of application techniques (e.g. pre- or or post- ) and/or crop situation by selecting different monitoring sites each year.

This report will summarize the results from this study.

## SITE SELECTION

In consultation with staff of the Irrigation Branch, Saskatchewan Agriculture, a site was selected that met the following requirements:

1. Irrigation inflow and drainage outflow could be easily monitored.
2. The crop grown by the producer was "representative" of some of the crops grown in the irrigation area.
3. The inputs to the crop grown included the use of herbicides and pesticides.
4. The owner of the field site was a willing co-operator who allowed access to the field site to collect soil and water samples, and provided information as to the farming practices and inputs utilized, etc.

The site selected for the 1986/87/88 field season that met the criteria was located on the farm of Roger Pederson N.E.1/4, SEC. 17, TWP. 28 ,RGE 7, W.3rd.Details of the study area, land treatment, etc. are as follows:

1. 16.7 hectares irrigated by corrugation method.
2. Prior to seeding, the area was fertilized with anhydrous ammonia at a rate of 107 kg/ha in 1986 , 147 kg/ha in 1987 and 84 kg/ha in 1988 of total nitrogen.
3. At the time of seeding with soft white spring wheat (Triticum aestivum), fertilizer was applied at the following rate:

| | 1986 | 1987 | 1988 |
|---|---|---|---|
| Nitrogen | 11.2 kg/ha | 5.6 kg/ha | 5.6 kg/ha |
| Phosphorous | 56.1 kg/ha | 28.0 kg/ha | |
| Potassium | 22.5 kg/ha | | |

4. In 1986 the crop was sprayed with Dyvel (336 g MCPA and 84 g Dicamba active ingredient per hectare) while in 1987 Hoe Grass(Diclofop methyl; 284g active ingredient per hectare) and Dyvel were used. In 1988 Hoe-Grass II (310g active ingredient/ha. ; 23:8 diclofop methyl and bromoxynil) and 2,4-D+,MCPA (500g active ingredient/ha.) were applied.

## INSTRUMENTATION and DATA COLLECTION

### Inflow ( applied irrigation water and outflow )

The inflow was determined by measuring the pumping rate with a doppler flow meter. Runoff was measured using a V shaped (one to two) sharp crested weir and a Stevens A-35 recorder. The runoff rate was calculated from the head measured by the recorder. A specially designed programmmable sampler (SRC sampler) was used to collect the water samples for herbicide and nutrient analysis without contamination.

## Rainfall

Rainfall was measured with a totallizing tipping-bucket raingauge.

## Water Samples

Background water samples were taken from the supply of irrigation water as it left the pipe. A minimum of two samples were taken for each section of the irrigated field. Runoff samples were taken every hour with the SRC water sampler at the weir site.

## Water analysis

Water samples were analyzed for nutrients ( total phosphorous, ortho-phosphorous, total dissolved nitrates and nitrites, total ammonia and electrical conductivity ) by the Water Quality Laboratory of Environment Canada according to standard procedures outlined by Traversy (1971).

For analysis of Dicamba/MCPA and Diclofop in water the methodology utilized was as follows:

- Take 500 ml of unfiltered water sample and place in 1000 ml separatory funnel.
- Adjust pH to less than 2.0
- Add 80 grams of NaCl and shake.
- Extract the acid forms of Dicamba/MCPA by shaking with 2 x 100 ml portions of diethyl ether.
- Run each diether extract through a funnel containing 25 gms of anhydrous Na2So4 and into a 500 ml flat bottom boiling flask.
- Rinse the funnel with an additional 10 ml diethyl ether.
- Evaporate the diethyl ether to dryness on a rotary evaporator at 40 C.
- Azeotrap any water remaining by adding 20 ml acetone, placing on the evaporator and taking to dryness.
- Transfer the residue from the 500 ml boiling flask, into a 50 ml graduated centrifuge tube using 5 x 2 ml portions of diethyl ether.
- Evaporate the diether to approximately 1.0 ml on the N2 evaporator.
- Sample is now ready for methylation.
- Methylate by adding 2 ml of diazomethane to the centrifuge tube, and allow to stand for 15 minutes.
- Transfer the methyl ester of Dicamba/MCPA from the diethyl ether into hexane by adding 2 x 2 ml portions of hexane, placing on the N2 evaporator and concentrating down to 1.0 ml.
- Sample is now ready for column clean-up.

Column Clean-up

- Wet pack a 7 mm I.D. chromatographic column with 4 ml of 5% deactivated forisil, 60/80 mesh.
- Prewash the column with 10 ml hexane.
- Transfer the sample to the column in 1.0 ml hexane.
- Elute the column with 30 ml of 0.5% acetone in hexane, while collecting the 10 to 30 ml fraction containing the methyl esters of dicamba/MCPA.
- Concentrate the elute to less than 1.0 ml.
- Transfer to 1.0 ml voumetric flask and bring to volume.
- Ready for GLC analysis.

Gas Chromatograph Conditions (for Dicamba/MCPA)

- Gas Chromatograph: Tracor 560 equipped with a Hall 700 A detector, operated in the Cl mode.
- Column: Ultra Bond 4 mm I.D. x 1.8 m.
- Temperatures: Column: 170 C isothermal
  Injector: 220 C
  Furnace Base: 250 C
  Furnace: 810 C
- Gas Flows: Column: 25 ml/min Helium (UHP)
  Reaction gas: 20 ml/min Hydrogen (UHP)
- Solvent Flow: 0.7 ml/min N-propanol
- Integration: Varian Vista 401 Data System
- Injection: Varian 8000 autosampler, on column
- Retention Time: Under the above conditions Dicamba and MCPA had a retention time of 3.71 and 5.10 minutes respectively.

Gas Chromatagraph Conditions ( for Diclofop Methyl)

- Gas Chromatagraph : Hewlett-Packard 5890, eqiupped with a Ni63 ECD detector.

- Column : HP-1, 25 m. in length x 0.53 mm. I.D., fused silicon, cross linked and having a film thickness of 0.88 microns.

- Temperatures : Column : Temperature programmed starting at 70 C for 1 minute then 6 C/min to 270 C held for five minutes.
  Injector: Cool on column
  Detector: 350 C

- Gas Flows : Column : 5 ml/min Helium (UHP)
  ECD Purge : 70 ml/min Nitrogen (UHP)

- Injection : Hewlett-Packard 7673 Autoinjector

- Retention Time : Under the above conditions Diclofop Methyl had a retention time of 31.74 minutes.

## RESULTS and DISCUSSION

### Irrigation Efficiency (with respect to surface drainage water only):

The amount of surface drainage water expressed as percentage of applied irrigation water for each irrigation and for the season's irrigation is presented in Table 1.

* Using a soil moisture budget, calculated using the Versatile (VBCCHINA)model (Dyer and Mack, 1984), coupled with soil moisture measurements (data not shown) indicated actual evapotranspiration exceeded the sum of precipitation and the applied irrigation water each year. As a result, deep purcolation was considered to be minimal.

The irrigation efficiency of the corrigation system in this study was in the order of 75 to 90 % compared to the average of 70% reported in Alberta (Monaghan and Pungor, 1985).

Table 1. Amount and % surface drainage water for each irrigation.

| Year | | Total Acc. Inflow $M^3$ | Total Acc. Run-off | % Drained |
|---|---|---|---|---|
| 1986 | 1st irrigation | 16,615 | 2,135 | 13 |
| | 2nd irrigation | 11,424 | 1,864 | 16 |
| | | | Total % Drained | 14.3 |
| 1987 | 1st irrigation | 24,331 | 2,895 | 12 |
| | 2nd irrigation | 18,348 | 1,619 | 09 |
| | | | Total % Drained | 10.5 |
| 1988 | 1st irrigation | 15,162 | 3,097 | 20 |
| | 2nd irrigation | 7,391 | 2,496 | 34 |
| | 3rd irrigation | 9,971 | 2,418 | 24 |
| | 4th irrigation | 12,032 | 2,276 | 19 |
| | | | Total % Drained | 23.1 |

## Nutrient loss

The range of concentrations of nutrients found in both supply water and drain water are noted in Table 2.

Table 2. Nutrient concentrations found in supply and surface drainage water.

| Year | Supply Water min | Supply Water max | Drain Water min | Drain Water max |
|---|---|---|---|---|
| | mg/L | | | |
| 1986 | | | | |
| Total Phosphorus | 0.015 | 0.027 | 0.10 | 0.40 |
| Ortho-phosphorus | 0.003 | 0.003 | 0.003 | 0.26 |
| Dissolved NO2+NO3 | 0.04 | 0.06 | 0.05 | 0.74 |
| Total Ammonia | 0.05 | 0.07 | 0.09 | 0.54 |
| 1987 | | | | |
| Total Phosphorus | 0.012 | 0.095 | 0.10 | 0.75 |
| Ortho-phosphorus | 0.003 | 0.016 | 0.06 | 0.36 |
| Dissolved NO2+NO3 | 0.22 | 0.33 | 0.42 | 1.95 |
| Total Ammonia | 0.006 | 0.025 | 0.01 | 0.24 |
| 1988 | | | | |
| Total Phosphorus | 0.019 | 0.058 | 0.018 | 1.12 |
| Ortho-phosphorus | 0.007 | 0.028 | 0.005 | 0.45 |
| Dissolved No2-no3 | 0.247 | 0.445 | 0.264 | 3.34 |
| Total Ammonia | 0.005 | 0.006 | 0.005 | 0.66 |

The maximum phosphorus levels observed in the water are in excess of the maximum acceptable level of 0.1 mg/L recommended for domestic consumption (McNeety et al.1979). The weighted mean concentration of 0.29, 0.22 and 0.69 mg/L for 1986, 1987 and 1988 respectively is higher than the acceptable level.

The loss of applied nutrients as determined by analysis of drainage water is presented in Table 3 . Noted is the loss of applied nutrients expressed as kg/ha and % of the amount applied.

Table 3. Nutrient loss in surface drainage water expressed as a percentage of the amount of applied fertilizer.

| Nutrient | Applied | Loss (1st.) (Irr.) | Loss (2nd) (Irr.) | Total Loss | |
|---|---|---|---|---|---|
| Year | | | | | % |
| | kg/ha | | | | |
| 1986 | | | | | |
| Nitrogen | 118.2 | 0.09 | 0.03 | 0.12 | 0.10 |
| Phosphorous | 56.1 | 0.04 | 0.03 | 0.07 | 0.12 |

| | | | | | |
|---|---|---|---|---|---|
| 1987 | | | | | |
| Nitrogen | 147 | 0.11 | 0.04 | 0.15 | 0.10 |
| Phosphorous | 28 | 0.04 | 0.02 | 0.06 | 0.22 |
| 1988 | | | | | |
| Nitrogen | 89.6 | 0.14 | 0.18 | 0.43 | 0.48 |
| Phosphorous | ----------not applied---------- | | | | |

Note:(1) Due to extreme dry conditions there were four irrigation events in 1988.(2) Data for 3rd and 4th irrigation not included.

The total amount of nutrient loss expressed as a percentage of applied fertilizer was found to be very low. The levels were found to be comparably less than from a non-irrigated stubble and unfertilized summerfallow field (Nicholaichuk and Read, 1978).

Herbicide Loss:

The range of concentrations of herbicides found in both the irrigation water and the drain water are noted in Table 4. The levels of MCPA and Dicamba are within the LC50 limits of for aquatic invertebrates (U.S.P.A. Factsheet, 1983). It must be recognized that these chemicals degrade by as much as 50% in a two week period.

Table 4. Herbicide concentrations found in irrigation and surface drainage water.

| Year | Irrigation Water min | Irrigation Water max | Drain Water min | Drain Water max |
|---|---|---|---|---|
| | ----------ug/l---------- | | | |
| 1986 | | | | |
| DICAMBA | <0.1 | <0.1 | <0.1 | 4.3 |
| MCPA | <0.1 | <0.1 | <0.1 | 10.7 |
| 1987 | | | | |
| DICAMBA | <0.1 | <0.1 | 0.1 | 4.7 |
| MCPA | <0.1 | <0.1 | 0.1 | 12.9 |
| DICLOFOP | <0.1 | <0.1 | 0.2 | 17.4 |
| 1988 | | | | |
| 2,4-D | N.D | N.D | 0.4 | 3.5 |
| DICLOFOP | N.D | N.D | 0.1 | 63.8 |
| BROMOXYNIL | <0.1 | <0.1 | 0.2 | 20.4 |

The loss of applied herbicides as determined by analysis of drainage water is presented in Table 5. Noted is the loss of applied herbicides expressed as g/ha and % of the amount applied.

Table 5. Herbicide loss in surface drainage water expressed as a percentage of the amount of applied.

| Year | Herbicide | Total g. Applied | Loss (1st.) (Irr.) | Loss (2nd) (Irr.) | Total Loss | Loss | Weighted Mean |
|---|---|---|---|---|---|---|---|
| | | | g/ha | | | % | ppb |
| 1986 | | | | | | | |
| | DICAMBA | 1753 | 0.11 | 0.02 | 0.13 | 0.12 | 0.53 |
| | MCPA | 7014 | 0.45 | 0.02 | 0.47 | 0.11 | 1.82 |
| 1987 | | | | | | | |
| | DICAMBA | 1753 | 0.17 | 0.01 | 0.18 | 0.17 | 0.66 |
| | MCPA | 7014 | 0.55 | 0.01 | 0.56 | 0.13 | 2.07 |
| | DICLOFOP | 12568 | 1.34 | 0.03 | 1.37 | 0.18 | 5.07 |
| 1988 | | | | | | | |
| | 2,4-D | 9185 | | | 0.32 | 0.06 | 0.52 |
| | DICLOFOP | 13442 | | | 5.85 | 0.73 | 9.52 |
| | BROMOXYNIL | 4676 | | | 2.07 | 0.74 | 3.36 |

Note: Data for the 3rd and 4th irrigations required in 1988 are included but not reported.

Based on the surface drainage discharge and hourly observations of concentrations of MCPA and Dicamba, most of the loss occurred during the first irrigation. However, the amount of loss is a very small percentage of the amount applied. The 0.17% loss of Dicamba was far less than 3.3% loss observed in a simulated 'catastrophic' rainfall event observed by Wauchope(1978).

Loss of both nutrients and herbicides is a function of agronomic practices. Suitable land use practices such as minimum tillage and crop rotations that minimize erosion and runoff losses will result in minimal environmental contamination through the use of chemical fertilizers and herbicides.

## CONCLUSIONS and IMPACT

Irrigating a soft white spring wheat crop in the South Saskatchewan Irrigation District in the 1986/1987 and 1987/1988 crop season using the corrugation method resulted in the following:

1. In 1986 2.4 cm(14.3%) of the applied irrigation water was returned as surface drainage water while 1987 had 2.71 cm (10.5%) return as surface drainage water. By comparison, in 1988 6.2 cm(23.1%) of the applied irrigation water was returned as surface drainage water. On the average, the amount of surface drainage from the corrugation irrigation is comparable to the literature from Alberta and could be used for estimating irrigation return flow directly off farm fields.

2. In 1986 0.12 kg/ha(0.1 %) of the applied nitrogen and 0.07 kg/ha(0.12%) of the applied phosphorous was lost to surface drainage. By comparison 1987 had 0.15 kg/ha(0.1 %) of the applied nitrogen and 0.06 kg/ha(0.22 %) of the applied phosphorous lost to surface drainage. In 1988, 0.43 kg/ha(0.48 %) of the applied nitrogen was lost while no phosphorous was applied. The loss of applied fertilizers is considered to be low when compared to the loss of nutrients from an unfertilized fallow field under dryland conditions (Nicholaichuk and Read, 1978).

3. Maximum concentrations of nutrients and herbicides were observed as follows:

| 1986 | 1987 | 1988 |
|---|---|---|
| - 0.40 mg/L total p | 0.75 mg/L total P | 1.12 mg/L total P |
| - 0.26 mg/L ortho-P | 0.36 mg/L ortho-P | 0.45 mg/L ortho-P |
| - 0.74 mg/L diss. N | 1.95 mg/L diss. N | 3.34 mg/L diss. N |
| - 0.54 mg/L total N | 0.24 mg/L total N | 0.66 mg/L total N |

- In 1986, 0.13 g/ha or 0.12% of the applied Dicamba and 0.47 g/ha or 0.11% of the applied MCPA was observed in the surface drain water from both irrigations. In comparison, 1987 had 0.18 g/ha or 0.17% of the applied Dicamba, 0.56 g/ha or 0.13% of the applied MCPA and 1.37 g/ha or 0.18% of the applied Diclofop was observed in the surface drain water from all irrigations. In 1988 0.32 g/ha or 0.06% 2,4-D, 5.85 g/ha or 0.73% Diclofop and 2.07g/ha or 0.74% of the applied Bromoxynil was observed in the surface drain water from all irrigations. Although comparative data for the loss of Dicamba, MCPA and Diclofop are not available for dryland agricultural conditions in Saskatchewan, the loss of 2,4-D was found to be comparable for surface irrigated conditions compared to spring runoff fields where fall 2,4-D was applied (Nicholaichuk and Grover, 1983).

Data suggests that herbicide losses occur primarily during the first irrigation. As a result, if drain water is to be reused for subsequent irrigations, it may be necessary to avoid using the surface drain water that occurs after the first irrigation for very sensitive crops.

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## LIST OF PERSONNEL INVOLVED IN THE PROJECT

| Technical Staff Employed By Project | % Time |
|---|---|
| Lorne Kerr - Agricultural Canada | 30 |
| Andy Aubin - Agricultural Canada | 30 |
| Nick Nicolichuk - S.R.C. | 30 |
| Rod Bouvier - S. R.C. | 10 |

NHRI Technical Staff Assigned to Project

| | |
|---|---|
| Kelly Best | 40 |
| Keith Wallace | 20 |
| Vivian Wasiuta | 20 |
| Ross MacKay | 20 |
| Newell Hedstrom | 20 |

Professional Staff Associated with the Project

Dr. Raj Grover - Agricultural Canada
Jeff Whiting - Sask. Research Council
Harm Maathuis - Sask. Research Council
Duane McNaughton - NHRI
Garry Grove - NHRI
Dr. Wally Nicholaichuk - NHRI
Garth Wieterman - Sask Water Corp

## LIST OF EQUIPMENT PURCHASED

None